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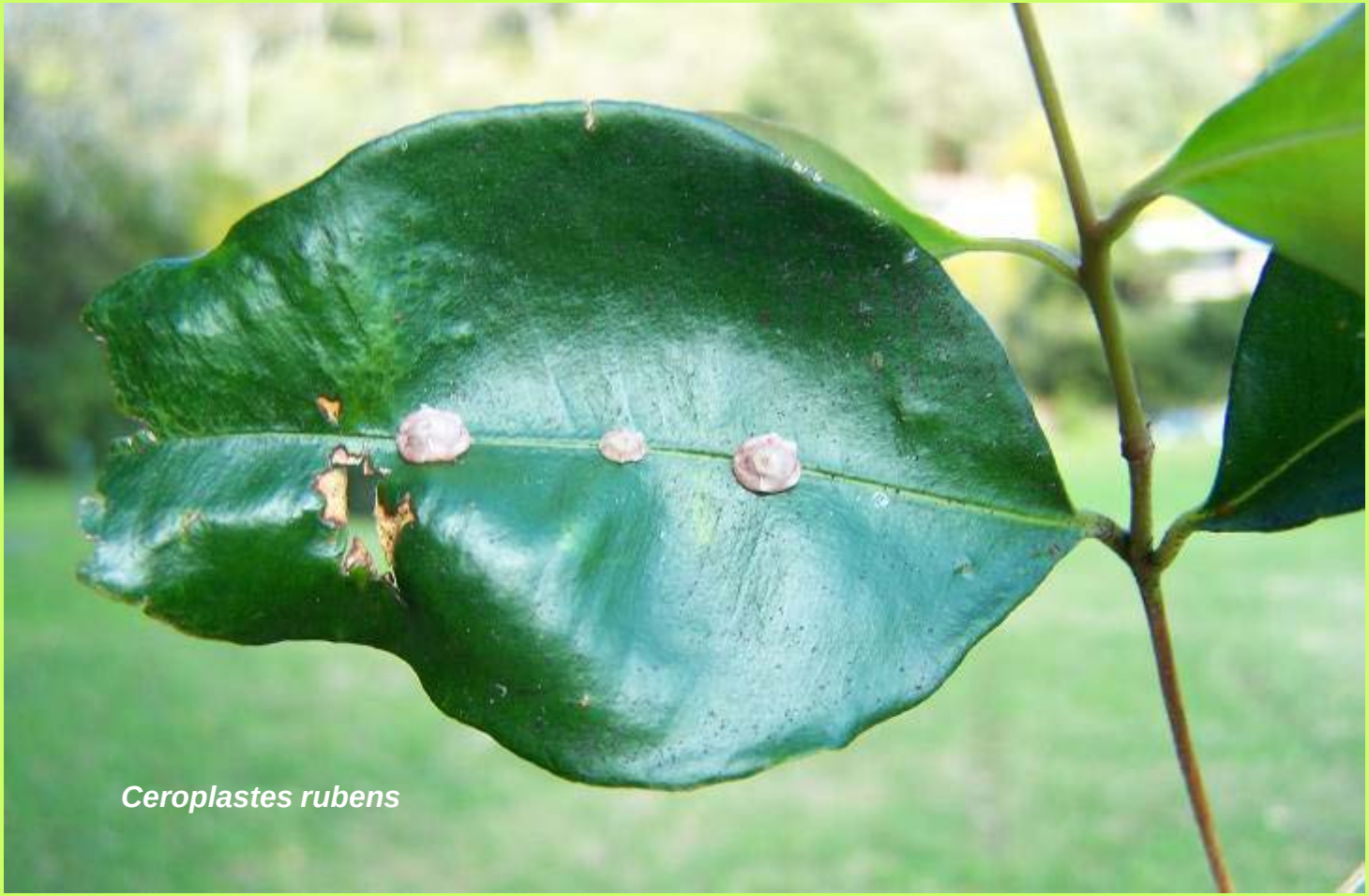
Flow-on benefits of biological control of scale insects invading natural ecosystems in Australia



Scale-infestations invade natural plant communities: detrimental effects -

- Scales drain sap and lower nutrient flow; cause death and senescence of leaves and stems
- sooty mould grows on the honeydew – lowers photosynthesis
- reduce sap flow reduces emergent growth, flowering and seed production
- infestations displace activity by herbivores, parasitoids & predators; and can restrict symbiosis

Abundance of honeydew, sooty mould and exotic ants have major flow-on effects in all ecosystems

Scale infestations affect indigenous arthropod herbivores and parasitoids

- Herbivore feeding and mobility is restricted by honey dew and mould
- Sooty mould influences host recognition, feeding, mobility & oviposition site selection by small parasitic insects
- Honey dew attracts ants – particularly exotic & invasive ant species
- Abundant exotic ants repel natural enemies and displace native fauna
- Some predatory insects (e.g. Chrysomelidae) are less effected by the abundant ants

Cupaniopsis anarcardioides

Major scale insect groups invading ecosystems: invasive significance has been reduced by biological control

Most important group	Est. significance
• Coccidae (many polyphagous)	+++
• Diaspididae (mostly on monocots)	+
• Margarodidae (some polyphagous)	+++

Wax scales (Coccidae) invaded crops and Australian National Parks before the 1960s

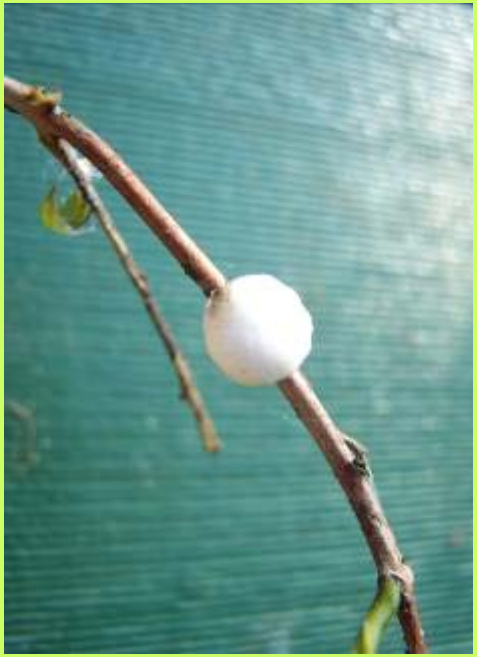
- Two polyphagous wax scales *Ceroplastes destructor* and *C. rubens* (both from Africa) became major pests of citrus and garden plants in the 1900s
- Infestations spread into rainforest, woodlands & heaths. Leaves and stems of Myrtaceae, Sapindaceae, Rutaceae, Pittosporaceae + 10 other plant families became infested with scales and sooty mould
- Honeydew, mould and exotic ant abundance discouraged people from entering national parks
- 1968-1972: Encyrtids *Anicetus communis* (temperate) and *A. nyasicus* (tropical) introduced into Australia from S. Africa
- 1968 - Biological control of *C. destructor* achieved in crops and other ecosystems

Ceroplastes destructor

Example: Ceroplastes destructor (Coccidae)

origin: South Africa

- A major pest of citrus <1970
- Damage to plants caused by scales from sap removal & sooty mould
- An ecosystem invader > 100 indigenous plant hosts
- Honey dew excretions attracts exotic ants
  e.g *Phidole megacephala*



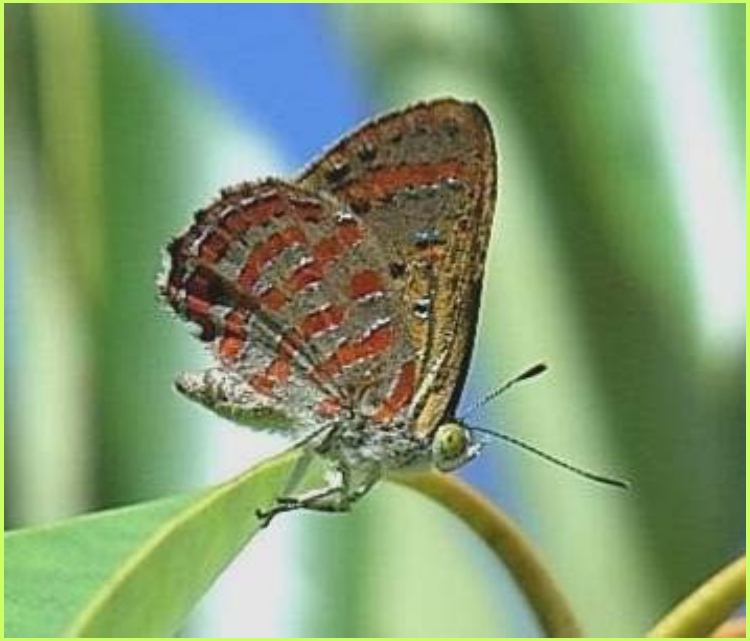
Ceroplastes destructor

FLOW-ON EFFECTS FROM ANTS

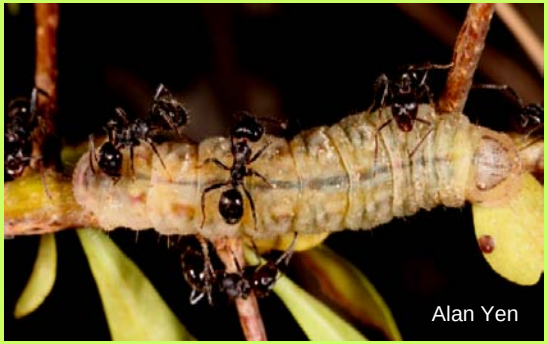
Exotic ants were attracted by the honey dew excreted by scales -

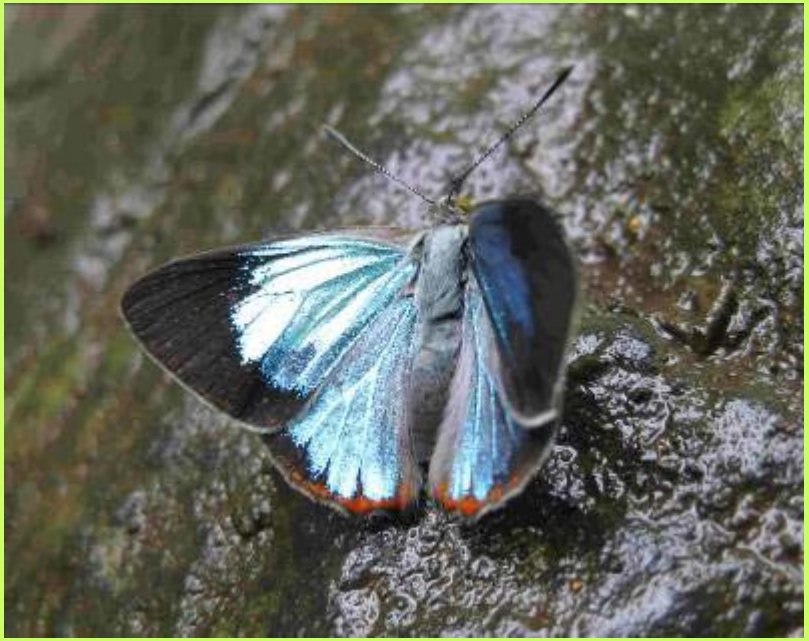
- forage on scale-infested and nearby un-infested plants
- prey on a range of indigenous insects
- replace or reduce indigenous ants near infestations
- prevent indigenous ants from their symbiotic interactions
- protect the invasive scales from parasitoid attack and predation

Lycaenids became rare or disappeared from native ecosystems when attendant ants were displaced by exotic ants



Hypochrysops ignitus:
Larvae and pupae attended by Papyrius nitidus





Hypochrysops delicia
Larvae and pupae attended by *Crematogaster* sp.

EXAMPLE: THE SCALE (*CEROPLASTES DESTRUCTOR)* IN A NATIONAL PARK

Rainforest site: Burleigh Heads National Park, South east Queensland. Monitored 1967 -

- Scale (*C. destructor*) infested ecosystem including butterfly food plants (*Smilax australis, Diospyros fasiculosa, Guioa acutifolia) **

- Native ants were displaced by exotic ants (e.g. *Pheidole megacephala* and *Tetramorium* sp.)

** monitoring1968 – 1972, revisited 2000 - 2009*

Butterflies and ant responses - after the scale invasion

Lycaenid butterflies

- *Pseudodipsas cephenes* – disappeared from well-known Burleigh Heads habitat

- *Hypochrysops miskini* - became rare at the same site

Ants

- Indigenous ants (*Anonychomyrma gilberti)* attending butterflies were displaced or became rare.

- Their habitat shelters (hollow stems, rolled leaves) were taken over by exotic *P. megacephala*.

Biological control of *C. destructor* *in Australia*

• South African encyrtid parasitoids *Anicetus communis* and *A. nyasicus* became firmly established by 1968 – 1972

•Observed benefits to plants included declines in scale densities, honey dew secretions, sooty mould and ant densities by 1971

•Biological control of *C. destructor* enabled recovery of plants and many associated (beneficial) insects in citrus orchards as well natural plant communities by 1974

A flow-on responses by an indigenous ant and the butterflies it attended

In rainforest

- Re-appearance of the native ant (*Anonychomyrma gilberti)* attending lycaenid butterflies

- Return of one lycaenid butterfly *Hypochrysops miskini* to Burleigh Heads National Park

- Little evidence of recovery by *Pseudodipsas cephenes* in 1972 and none seen between 2001- 2009)

In eucalypt woodlands another lycaenid, *Hypochrysops ignitus* and its attending ant *Papyrius nitidus,* did not return to their pre-scale infested levels of abundance